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Identifying and Analyzing Stratums in Virtual Reality Geological Environment: A Three-Dimensional Approach

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Abstract

The research of a high-technology measure for geologists using virtual reality (VR) technology has enabled the representation of geological data in both static and dynamic formats. This study proposes a three-dimensional approach for identifying and analyzing stratums in VR geological environments, consisting of three steps: pretreating geological data, constructing three-dimensional stratum models, and visually analyzing and correcting space. These steps are verified and detected using a space information quality detecting model. The combination of three-dimensional stratum geometrical identification, multi-dimensional attribute identification, static and dynamic simulation visualization technologies, and physical rules identification and analysis methods results in the construction of realistic VR geological environments.

Keywords

Virtual reality, stratums, three-dimensional models, geological data, space visualization, dynamic simulation

Introduction

In recent years, virtual reality technology has become increasingly popular in geological research due to its ability to create realistic geological environments that can be explored and analyzed. Identifying and analyzing stratums in geological environments is essential for understanding geological structures and predicting potential hazards. However, traditional two-dimensional representations of geological data often fail to capture the complexity of geological structures.[1] This study proposes a three-dimensional approach for identifying and analyzing stratums in VR geological environments, which overcomes the limitations of two-dimensional representations and enables the construction of realistic VR geological environments.

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Related work

The research background being described is related to the use of three-dimensional geological recognition technology and virtual reality (VR) in geological research. The goal of this technology is to provide geologists with a tool to better understand the spatial distribution of geological units, lithology, and ore deposits. By utilizing existing geological data, it is possible to identify and visualize strata, providing a better understanding of the geological features. This technology can also be used to test completed prospecting work, provide strong geological basis for follow-up exploration and design, construction operation, and geological prospecting, urban planning.[2]

The complexity and uncertainty of geological phenomenon means that geologists must consider multiple geological factors and complex conditions when carrying out stratum identification and simulation. This technology creates multiple possible realizations within a certain scope to produce an optimum, the most reasonable, and the best modeling scheme to meet geologic rules. It helps to disclose the internal construction of geological bodies, the changing pattern of spatial complexity, and the distribution characteristics of property parameters. This technology allows for the comprehensive, integrated research, and management of 3-D quantification, which directly reflects the factors such as uncertainty in the geological phenomenon. It provides a solid support for geologists' research and development and improves the ability to analyze geological bodies, including the prediction of bore position and the verification of fault parameters.[3,4]

This technology is based on multi-source data, including geological data, photogrammetric data, remotely-sensed data, and geophysical data. As technology rapidly develops, such as exploration geophysics and remote sensing image processing, it is possible to couple the multi-source data of geologic data, photogrammetric data, remotely-sensed data, and geophysical data. This coupling makes it possible to set up the 3D complex geological model quickly and accurately, laying a good foundation for complex geologic bodies such as thrust, overfold to carry out resource analysis and evaluation. The geological model and information processing system based on multi-source data can also provide an important economic decision-making foundation, such as investment preference strategy, development plan, following exploration budget, etc.[5,6]

The VR geological environment is made up of two main components: hardware and software. The hardware components include input processing equipment, output treatment facility, and a professional graphics workstation or high-performance RC machine. Data acquisition equipment is the primary input processing equipment, mainly comprising field acquisition equipment, data scanning instruments, and plotters, which finish the field acquisition of data and scanner uni-vectorized process of data. Other input processing equipment is mainly used to realize the interactive mode input and the input processing in batches of data. Input equipment with data entry systems imports the 2D/3D data model to realize the interactivity operation of the user and VR scene

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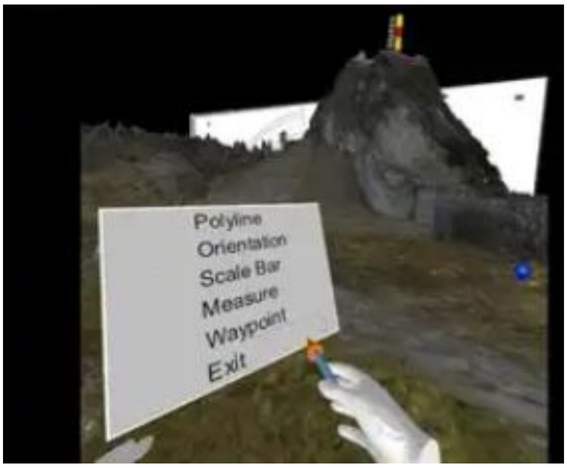
simultaneously, roam with viewpoint position, trace information, acquiring object, the VR that determines to draw VR geology, etc.[7,8]

The output is mainly finished by visual signal, audible signal, haptic signal, and scent signal. At present, the primary output is still visual and audible signals, and technology maturity is the best. The main output equipment includes perspective transformations devices, anaglyph spectacles, Helmet Mounted Displays, stereo-projection curtains, stereo projectors, etc. The perspective transformations device converts various planed signals into a three-dimensional signal and can realize the perspective transformations of video images from 2D-to-3D. Anaglyph spectacles are used to watch stereo scenes, simulated effects, based on the anaglyph spectacles of page or leaf switch mode, divided into wired and wireless two kinds.[9]

Research Objective

The primary objective of this study is to develop a three-dimensional approach for identifying and analyzing stratums in VR geological environments. The specific objectives are as follows: (1) to pretreat geological data to ensure its quality and accuracy, (2) to construct three-dimensional stratum models that accurately represent geological structures, (3) to visually analyze and correct space to ensure the accuracy of the VR geological environment, and (4) to verify and detect each step of the approach using a space information quality detecting model.



The research discussed in the previous question offers several advantages to the field of geology. One of the primary benefits is the ability to accurately identify three-dimensional formations and their properties, providing geologists with a deeper understanding of the geologic structures they are studying. This is achieved by integrating and fusing multi-source data into an integrated three-dimensional model and identifying the stratal surface model and structure. The research also enables

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the representation of geologic data in a spatially accurate manner, which is a significant advantage in the field of geology.

Another benefit of this research is the use of physical rules, models, and related applications to facilitate the interpretation of data. This enables geologists to make more informed decisions and derive meaningful insights from the data. Additionally, the dynamic analog visual analysis method allows for the dynamic expression of the geological model, both spatially and temporally, enhancing the visualization of the geologic structures.

Finally, the research enables the creation of a virtual reality geology reality, which simulates geological environments that may be difficult to access in the real world. This provides geologists with a new high-tech means of exploring the face of the land or the underground world. Overall, the research offers several advantages to the field of geology and has the potential to revolutionize how geologists' study and understand geologic structures.

Research

The present research is a method for identifying and analyzing three-dimensional geological formations using a combination of static and dynamic simulation visual analysis techniques. This method aims to provide a more accurate and realistic representation of geological data, both spatially and temporally. The research also provides a physical model and related application for analyzing and representing geological data, and a knowledge representation method to facilitate the interpretation of this data.

The first step of this method is data interpretation and identification. This includes data acquisition, collating sort, analysis parsing, and inference. The geologic data is then subjected to preliminary treatment, which involves dividing it into core, geological boundary, stratum, tomography, fold, section, DTM/DEM data, etc. The data is then formatted according to the GeoSIS system requirements of the inventor's research and development. Once the data has been vectorized, it is input or imported and the quality is checked. These geologic data serve as the foundation for the identification and creation of three-dimensional formations.

The next step is the identification of the three-dimensional formation model. This is achieved by integrating and fusing the multi-source data into an integrated three-dimensional model. The fold model, rock stratum initial model, FAULT MODEL, etc. are established based on this integrated three-dimensional model. The stratal surface model is then generated using SSI computing, curved surface merge algorithm, etc. Finally, the stratum physical model and layer attribute model are identified and created.

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The identification of the stratal surface model and structure includes several steps. First, the geologic interpretation is corrected based on stratum identification. Then, the different aspects are divided, and the level and Changing Pattern of the vertical direction are determined. Next, the fault plane and stratal surface are identified, and the boundary face is reconstructed. The topological structure of the stratum is then established based on the operating results of the previous steps. The level ergodic algorithm is used to carry out the stratum automatic identification, search, and maintenance.

The last step is the spatial visualization analysis corrections. The model is subjected to reliability testing and revision, and if the accuracy does not meet the user's requirements, the data, parameter or model is corrected. The spatial information quality examination model is used to reduce data error and improve model accuracy.

1. Data interpretation and identification: This involves acquiring, collating, sorting, analyzing, parsing, and inferring geologic data. The data is then subjected to preliminary treatment, which involves dividing it into different categories such as core, geological boundary, stratum, tomography, fold, section, DTM/DEM data, etc. The data is then formatted according to the GeoSIS system requirements of the inventor's research and development. Once the data has been vectorized, it is input or imported and the quality is checked.
2. Identification of the three-dimensional formation model: In this step, the multi-source data is integrated and fused into an integrated three-dimensional model. The fold model, rock stratum initial model, FAULT MODEL, etc. are established based on this integrated three-dimensional model. The stratal surface model is then generated using SSI computing, curved surface merge algorithm, etc. Finally, the stratum physical model and layer attribute model are identified and created.
3. Identification of the stratal surface model and structure: This step involves correcting the geologic interpretation based on stratum identification. Then, the different aspects are divided, and the level and changing pattern of the vertical direction are determined. Next, the fault plane and stratal surface are identified, and the boundary face is reconstructed. The topological structure of the stratum is then established based on the operating results of the previous steps. The level ergodic algorithm is used to carry out the stratum automatic identification, search, and maintenance.
4. Spatial visualization analysis corrections: In the last step, the model is subjected to reliability testing and revision, and if the accuracy does not meet the user's requirements, the data, parameter, or model is corrected. The spatial information quality examination model is used to reduce data error and improve model accuracy.

The present research provides several benefits. It allows for the accurate identification of three-dimensional formations and multidimensional property identification, and enables the representation

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of geologic data in a spatially accurate manner. The physical rules, model, and related application, as well as knowledge representation, facilitate the interpretation of this data. The dynamic analog visual analysis method enables the dynamic expression of the geological model, both spatially and temporally. Finally, the research enables the creation of a virtual reality geology reality, which simulates geological environments that are attainable or difficult to realize, providing geologists with a new high-tech means of exploring the face of the land or the underground world.

In conclusion, the present research provides a comprehensive and integrated method for identifying and analyzing three-dimensional geological formations. The combination of static and dynamic simulation visual analysis techniques enables the representation of geologic data in a spatially and temporally accurate manner. This method provides a solid foundation for geologists to analyze geologic bodies, including the prediction of bore positions, verification of fault parameters, and the improvement of the method for handling spatial information.

Conclusion

This study proposes a three-dimensional approach for identifying and analyzing stratums in VR geological environments that enables the construction of realistic VR geological environments. The approach consists of three steps: pretreating geological data, constructing three-dimensional stratum models, and visually analyzing and correcting space. The space information quality detecting model is used to verify and detect each step of the approach. The combination of three-dimensional stratum geometrical identification, multi-dimensional attribute identification, static and dynamic simulation visualization technologies, and physical rules identification and analysis methods results in the construction of realistic VR geological environments. The proposed approach has the potential to revolutionize geological research by enabling the exploration and analysis of complex geological structures in a realistic VR environment.

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